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Gullies forming on a degraded landscape used for grazing in Morocco: researchers discuss restoration of the site by planting saltbush (*Atriplex*). Photo: E. van den Elsen

Saving soils at degradation frontlines: sustainable land management in drylands

Healthy soils are fundamental to life. They grow the food we eat and the wood we use for shelter and fuel, purify the water we drink, and hold fast to the roots of the natural world we cherish. They are the ground beneath our feet and beneath our homes. But they are under threat, especially from human overuse and climate change. Nowhere is this more evident than in dryland areas, where soil degradation – or desertification – wears away at this essential resource, sometimes with sudden rapidity when a tipping point is crossed. Though it is a challenge, preserving and restoring healthy soils in drylands is possible, and it concerns all of us. Sustainable land management points the way.

The research featured here is focused globally.

The threat of desertification

Desertification is insidious. It may not arrive with the fury of a hurricane or earthquake, but it is an environmental danger as big as any. Drought, loss of organic material, wind and water erosion, soil crusting, salinization, and other processes gradually render soils infertile. Twelve million hectares of fertile land are lost to desertification every year – three times the size of Switzerland.[1] If we do nothing, desertification could ultimately jeopardize our ability to feed ourselves.

Desertification occurs in dryland areas, which cover 40% of the Earth's land surface.[2] Despite their relative fragility, dryland ecosystems are home to two billion people.[3] They include Mediterranean shrublands where olive and fruit trees grow, African grasslands with their pastoralists, the Great Plains of North America, and the Eurasian steppe where herders still tread the Silk Road. What unites them is the scarcity, infrequency, or unpredictability of rainfall.

KEY MESSAGES

- We must tackle dryland desertification. It erodes productive soils and the livelihoods of 2 billion people. It destroys biodiversity, increases natural-disaster risks, contributes to population displacement, emits greenhouse gases, and threatens global food security.
- Sustainable land management offers a solution. It empowers rural communities in drylands, enabling them to halt or reverse desertification, increase production of food staples and livestock, improve incomes, preserve biodiversity and carbon sinks, maintain attractive landscapes for tourism, and more.
- Our tools help land users assess and select sustainable land management practices. This enables the informed, responsive, locally anchored stewardship that is needed to combat desertification.
- Funding and social support for land users practising sustainable land management should be maintained and expanded at every level. These land users protect and enhance public goods that benefit us all.

Box 1. World Overview of Conservation Approaches and Technologies (WOCAT)

Network: CDE researchers were founding members of WOCAT, a network of soil and water experts committed to documenting and sharing good practices of land use. Initially focused on conservation, they eventually developed the holistic concept of sustainable land management. This means using land resources – including soils, water, plants, and animals – to produce goods that meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions.[4]

Online database: Today, WOCAT maintains an open online database of over 450 sustainable land management practices from 50 countries. Visitors may freely search, view, and download user-friendly materials covering the background, analysis, and "how to" of different practices. Sharing is encouraged! (*https://www.wocat.net/en/knowledge-base/technologiesapproaches.html*)

Questionnaires: The database is continually fed with new data collected in the field – from everyday land users and experts alike – using structured WOCAT questionnaires.

UNCCD endorsement: Since 2014, the United Nations Convention to Combat Desertification recommends use of the WOCAT database to its signatories (over 190 countries) in order to document best practices of land use around the world.

Communities living in dryland areas are capable of stopping degradation and reviving healthy soils. Sustainable land management gives them the means. It turns the threat of desertification into opportunities: they can improve their productivity with minimal use of artificial inputs, increase biodiversity, create carbon sinks, maintain picturesque landscapes that attract visitors, and more.

Sustainable land management in drylands

CDE researchers have pioneered efforts to gather, document, assess, and share practices of sustainable land management through WOCAT (see Box 1). Many of the land use practices have been refined over generations by everyday land users who are experts at efficiently harnessing nature's productive power, even under austere natural conditions. Growing drought- and fire-resistant fruit trees within rotational grazing systems is one example. The researchers have recorded this vital knowledge, assessed its impacts on ecosystems and human well-being, and made it available for use by anyone anywhere.

Recently, CDE experts collaborated in a far-reaching five-year project, known as DESIRE, to study the impacts of sustainable land management technologies (and participatory ways of selecting technologies) in diverse dryland environments. The project studied 17 sites in 13 countries, from around the Mediterranean to as far away as China and Mexico.[5] A follow-up project, called CASCADE, focuses on the potential of these practices to prevent sudden, irreversible degradation in Mediterranean drylands (see Box 2).

Strips of aloe vera are planted to prevent erosion of a steep slope in Cape Verde. Photo: HP. Liniger

Sustainable land management varies from place to place, but generally involves the following:

Joint assessment of local challenges, resources, and way forward: Each community faces a unique set of challenges. Our approach thus begins by bringing together key stakeholders – land users, local authorities, and others – to set their sustainable land management goals and decide how to achieve them.[6,7] The goals might include reducing soil erosion and improving farm income. In two workshops, separated by a documentation phase using the WOCAT format, participants identify their problems (e.g. low productivity due to soil fertility loss), assess the potential solutions, and decide which technologies to implement. To maximize the likelihood of acceptance and to minimize the costs, priority goes to adapting and scaling up promising local practices. (Learn more at: *http://www.desire-his.eu/en/potential-strategies*)

Water, plants, structures, and stewardship: Sustainable land management practices focus on the following:

Water. They make every drop count. Instead of relying on irrigation water brought in from elsewhere, they capture, store, and channel what little rain does fall and make sure it is not immediately lost again through evaporation and surface runoff. Rainfall can be captured on roofs, in catchments, in recharge wells, etc. and directed into fields or into ponds for use later. There are many such *rainwater harvesting* technologies.[8,9] In Spain and Tunisia, farmers harvest water upstream and divert it into their fields. One such scheme increased the amount of water available to crops from 300 mm to 500 mm a year. A recharge well in Tunisia captures floodwater from sporadic heavy rains and feeds it into an aquifer for storage.

Light-footprint *irrigation technologies* save water. Drip irrigation delivers small amounts of water to crops through hoses laid on, or just below, the surface.

Plants. Trees, crops, grasses, or a combination of these are vital to fight desertification. Roots hold soils together; litter on the surface allows water to infiltrate. Trees provide shade and shelter, and ground cover breaks the impact of raindrops. But what plants to grow? One possibility is nitrogen-fixing crops in rotation with other crops. Some legumes require little water and can be eaten (as in the Chilean project sites) or used for livestock fodder (in Turkey and Morocco). They can also be

ploughed under to enhance soil fertility and structure, benefiting other crops (e.g. olives and almonds in Spain).

Elsewhere, it might be better to plant or preserve drought-resistant shrubs or trees. Large-scale afforestation can stabilize hillsides (documented in Cape Verde). Trees that protect the soil can also produce fuelwood (in Botswana) or fruits. Indeed, *multipurpose use of landscapes* is vital for sustainable land management.

Plant biodiversity is a natural extension of this. In Mexico, a community-led project included planting of agave (used to make drinks) in combination with grasses, shrubs, and trees – a panoply of plants serving many purposes.

Structures. Plants can form a living, durable barrier to heavy wind, rain, or floodwater. Planting dense rows of jatropha can prevent gullying on steep slopes in Ethiopia, for example.[10] Strips of aloe vera, agave, olive trees, or saltbush (*Atriplex*) also make for effective plant barriers.

Sometimes it is necessary to move earth in order to control erosion. In the loess plateau in China, farmers built up terraces over a period of 5–10 years and reinforced them with apple trees. Fences woven from branches (in Turkey), stone checkdams, and rock walls trap soils, reinforce terraces, or buttress plant barriers.

Stewardship. Tying everything together is the stewardship of drylands. Crops must be harvested and rotated. Barriers and terraces need upkeep. Pests and plant diseases must be kept in check. Forests need thinning to cut fire risks. Soil fertility and moisture levels require monitoring. In Tunisia and Italy, livestock keepers graze their animals only in certain areas, allowing other areas to recover. That prevents overgrazing, protects or even enhances soil health, and produces valuable milk and meat. Because two-thirds of drylands are used for grazing, this holds immense potential.[11]

Stewardship also includes no-till, a relatively new technique. This avoids ploughing; instead it uses special equipment to inject seeds directly into the soil. That preserves the soil cover and encourages water to infiltrate. It also keeps carbon in soils and out of the atmosphere, and costs less than conventional tilling due to labour and fuel savings. At sites used for cereal crops and orchards in Chile, Spain, and Greece, it reduced surface runoff and evaporation by over 50%.

Rural exodus: should I stay or should I go?

Soil health is the result of a duet between people and nature. It requires locally anchored individuals and communities who tend the land, manage cycles, and respond flexibly to natural variations. So the exodus from many dryland areas is a pressing concern. It is easy to understand why people want to leave: job opportunities seem better elsewhere, and farming and herding may be low status work. Young people are especially drawn to cities. At the sites documented, over half the land users relied on off-farm employment for more than half of their income. They were more interested in using sustainable land management practices to increase their profits or to get subsidies than because they were worried about the environment or wanted to beautify the landscape.[12]

More than anything, this highlights the need for national governments, regional bodies (e.g. the EU), and the private sector to provide adequate financial and social support (e.g. education) to dryland communities. Public awareness campaigns are needed to champion their work. By saving soils from desertification, they are doing nothing less than preserving life-support systems on behalf of everyone.

Current CDE research shows how land users often provide the last defence against catastrophic shifts in drylands, in which an environmental threshold is crossed (perhaps triggered by a fire[13] or landslide) and a whole landscape rapidly degrades.[14] It is much more cost-effective to invest in community-based prevention efforts than to restore landscapes already lost to degradation and desertification.[15]

Box 2. Featured research: DESIRE and CASCADE projects

The findings and recommendations in this brief stem largely from the EU-funded DESIRE project (2007–2012). CDE experts were key collaborators in the project, in which researchers and local stakeholders jointly identified, documented, and assessed use of sustainable land management practices to fight desertification in drylands. In all, the application and impacts of 30 practices were documented in 17 dryland study sites (3,000 km^2 of land in total). They were found to improve water management, reduce soil and vegetation degradation, improve land users' livelihoods, and have favourable long-term cost–benefit ratios (Schwilch et al 2012).[16] The follow-up CASCADE project (2012–2017) focuses on abrupt, often irreversible landscape degradation in drylands due to forest fires, overgrazing, or land abandonment. Researchers are studying how practices can minimize the risk of irreversible degradation and maximize the resilience of ecosystems. So far, 20 practices have been documented across six northern Mediterranean sites. (*https://www.cde.unibe.ch/Pages/Project/4/69/The-CASCADE-Project.aspx*)

A fire fighter in Portugal monitors the spread of a prescribed fire used to prevent the likelihood of a more damaging wildfire. Photo: H. de Herder

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Policy implications of research

Desertification threats demand a response

The risks of inaction on desertification are grave, while the opportunities of action are great. Inaction can lead to an accelerating cycle of lost productive land, biodiversity decline, natural disasters, population displacement, and rising carbon emissions. The solution is to stabilize or increase production of staple grains and grass-fed livestock, protect resilient plant species, empower rural communities, and keep carbon in soils. A continuous effort is needed to properly care for dryland ecosystems, always seeking a balance between people's needs and nature's ability to replenish itself.

We may be the cause, but we are also the cure

Sustainable land management is needed to prevent, halt, or reverse desertification in many dryland areas. Fragile ecosystems have evolved over centuries or millennia. Leaving them alone to return to their "natural state" is largely illusory and risky. A deforested dryland landscape that has been farmed for generations is unlikely to revert to wild forest if it is abandoned – it is more likely to turn into (fire-prone) badlands. Informed, responsive, locally anchored stewardship is needed to help nature flourish in a mutually beneficial way.

Supporting sustainable land use is an act of solidarity that benefits us all

Not long ago, most people farmed for a living and were intimately aware of their reliance on healthy soils. While our awareness of the importance of soils may have changed, our ultimate dependence on them has not. Sustainable land management is a wise investment in the present and the future. Even in relatively well-off European countries – especially those with drylands (e.g. Spain, Portugal, Greece) – people are concerned about being able to produce enough food nationally and regionally.[17] Sustainable land management helps preserve that ability, and the many other ecosystem services of healthy soils. Rural communities that practise this form of land use maintain public goods that benefit everyone. They deserve to derive a fair living and a sense of pride from their work.

Suggested further reading

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WOCAT website: https://www.wocat.net/
DESIRE website: http://www.desire-his.eu/
CASCADE website: http://www.cascadis-project.eu/

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